Syllabus of ME 4000O

Course Title

Introduction to additive manufacturing and rapid prototyping

Instructors and TA

- **Instructor:** Dr. Molong DUAN (duan@ust.hk)
- **Teaching assistant:** Dr. Stanley LEUNG (yunyuen@ust.hk)

Office Hour

Friday 4-6 PM at Rm 2563. Additional office hour by email appointment.

Course Description

This course serves as a general introduction to the underlying concepts of state-of-the-art additive manufacturing (AM) technologies. A wide range of representative processes (including fused deposition modeling, material jetting, selective laser sintering, direct energy deposition, stereolithography, digital light processing) is discussed in the AM of different materials. The physical principle, theoretical modeling, and the effects of different process parameters are derived and analyzed. Building on the knowledge of AM process, the computer-aided design (CAD) and computer-aided manufacturing (CAM) are reviewed; specific design principles for AM are discussed. The students are also expected to have hands-on experience with continuous carbon fiber printers through the design, fabrication, measurement, and testing of parts. Besides AM, other representative rapid prototyping techniques are also briefly discussed.

Learning Objectives

By the end of this course, the students will be able to:

- Understand different kinds of AM processes and their underlining principles,
- Select specific materials and AM processes for a given application,
- Evaluate, analyze, and optimize for the AM performance,
- Cultivate a “design-for-AM” skillset that leads to successful 3D prints,
- Create, fabricate, measure, and test parts with 3D printers.

Textbook

Gibson, I., Rosen, D. W., Stucker, B., & Khorasani, M. (2021). Additive manufacturing technologies. Springer.
https://link.springer.com/book/10.1007%2F978-3-030-56127-7

Reference Books

- Gebhardt, A., & Hötter, J. S. (2016). Additive manufacturing: 3D printing for prototyping and manufacturing. Hanser Publishers.
  https://www.sciencedirect.com/book/9781569905821/additive-manufacturing
- Srivastava, M., Rathee, S., Maheshwari, S., & Kundra, T. K. (2019). Additive manufacturing: fundamentals and advancements. CRC Press.
  https://www.taylorfrancis.com/books/mono/10.1201/9781351049382/additive-manufacturing-manu-srivastava-sandeep-rathee-sachin-maheshwari-kundra

Grading Policy

Homework	Midterm Exam	Final Exam	Lab	Project	Quiz
20%	20%	20%	20%	15%	5%

Extra points will be given to students **voted to be most helpful to others and future teaching of the course**.

Prerequisite

- MECH 2410 Engineering Materials
- MECH 2520 (3520) Design and Manufacturing (preferred)
- MECH 3510 CAD/CAM (preferred)

Course Schedule

Week	Topic
1	• Basic motivation, principle, and process of AM
2	• Development of AM technologies and different classifications • Representative industrial applications of AM • Comparison of AM technologies to subtractive manufacturing
3	• Extrusion-based AM systems • Fused deposition modeling • Material properties of thermoplastics polymers
4	• Vat photopolymerization AM systems • Material properties of UV curable materials • Stereolithography • Digital light processing
5	• Powder bed fusion AM systems • Material properties of the metal, polymer, ceramic powders • Laser sintering
6	• Direct energy deposition AM system • Processing–Structure–Properties Relationships • AM process planning • Five-axis fused deposition modeling AM
7	• Midterm exam • Material jetting AM system • Material jetting system modeling
8	• Binder jetting AM system • AM technologies for composite
9	• Review of CAD, CAM fundamentals • Design for AM
10	• Prelab (Design a continuous carbon fiber reinforced part) • Guidelines for process and material selection
11	• Lab (Manufacturing and testing of the designed part) • AM post-processing techniques
12	• Other rapid prototyping technologies
13	• Contribution of AM and rapid prototyping to smart manufacturing • Final report presentation